

Opportunities for Improving the Mine Action Process

James P. Trevelyan, Associate Professor
Department of Mechanical and Materials Engineering,
The University of Western Australia,
Nedlands 6907, Western Australia
E-mail: jamest@mech.uwa.edu.au
Web: <http://www.mech.uwa.edu.au/jpt/>

Text for presentation at the meeting of the Standing Committee of Experts on Technologies for Mine Action, 2nd Meeting, Geneva, May 2000.

Introduction

There are three ways to improve the mine action process to allow displaced people to return to their land sooner with less risk of injury. Naturally a major increase in aid funding would achieve a similar result using the existing process. However, the intention of this paper is to suggest steps which would achieve better outcomes with the same level of aid funding from the developed states. The paper suggests three main avenues for improvement:

- 1: Improving the technology, cost effectiveness and reliability of the mine clearance process,
- 2: Application of risk management approaches for managing mine contamination problems, and
- 3: Improving the utilisation of local resources, and seeking alternative sources of funding.

Most speakers at this conference will be addressing item 1 above. Most of our research at the UWA has also addressed this issue but we have started new research in the last 12 months to address the other two avenues. Therefore, the primary focus of this paper remains on item 1. However, we think that alternative approaches explored in 2 and 3 are just as likely to yield improvements and deserve much more intensive research and investigation.

Recent improvements

Before suggesting ways of improving the demining process it is essential to review some of the recent improvements. The process is not static. Deminers are constantly seeking improvements within the limited resources available and significant improvements in cost effectiveness have been made in the last few years. For example, in southern Africa mine detection dogs working with explosive vapour sampling filters, mine resistant vehicles with steel wheels, and other innovations have significantly improved the rate at which roads can be cleared. Flail machines have been introduced to speed up vegetation clearance. In Bosnia-Herzegovina and Croatia the effective combination of vegetation clearance machines, mine detection dogs and manual deminers has significantly reduce the cost of clearance per square metre (per sq. m). In Iraq and Afghanistan mine detection dogs have resulted in significant performance improvements, increasing the area of land cleared with the same resource import. Significant improvements in safety have been achieved in Afghanistan with a large reduction in demining accidents.

Again in Afghanistan, general-purpose machines like back hoes have significantly speeded up work in difficult demining conditions. The concept of "mechanical assistance in demining" has

of metal detectors which can work in mineralized ground conditions has significantly alleviated performance problems with metal detectors.

We have also addressed the issue of comfort for those clearing the mines. Lightweight, comfortable protective equipment and improved hand tools are now being manufactured in several mine affected regions at low-cost, such as in Zimbabwe, Pakistan and Cambodia.

However, at the same time, the number of countries requesting assistance for mine clearance has significantly increased and donations to individual countries are being stretched further and further. Major new mine problems have emerged in the Middle East, the Caucasus, Africa and America. Therefore, the rate of improvement has not been sufficient and much more significant advances are needed if we are to achieve significant progress in the next decade.

Road blocks impeding progress

There are several significant road blocks impeding progress. The technology needs to be improved but improved technology alone is not sufficient. Without significant improvements in program management, performance improvements from new technologies may never be realised. Human resources in mine action program management are not being used effectively and are spread too thinly. For example flails were introduced into Afghanistan several years ago but there was insufficient management expertise to ensure that they were used on appropriate tasks with appropriate levels of support. Flail clearance in Afghanistan cost approximately US\$2-00 per sq m or about 4 times the average manual clearance cost. The same problem will recur with new technologies if we do not address management issues at the same time.

Another road block is the lack of transparency in funding arrangements. For example, the normally quoted cost of demining in Cambodia does not include the enormous expenditure on foreign technical advisers. Technical advisers are usually supplied at no direct cost to demining programs: typically the cost is covered by internal transfers within governments, eventually at the expense of the aid budget. In-kind equipment donations, particularly large machines, also help to obscure real funding levels. Sometimes machines are made available on a leasing basis, sometimes a temporary loan, and sometimes as gifts to non government organisations. This makes it difficult to compare real costs and real performance levels. We will only make progress if we can make valid comparisons between different approaches. While technical performance is often difficult to measure, financial performance can be even more difficult. We have to be able to measure both.

Finally, there is a lack of intellectual rigour in mine action that leads to unnecessary debate, poor decision-making, slow progress with technology improvements and wastage of resources. For example, considerable time and energy was spent recently on the discussion of a new proposal for a demining quality standard based on the concept of acceptable quality level (AQL): the number of mines remaining after clearance per square metre (GICHD 2000). According to informed sources, the level proposed was higher than the density of mines in most Afghanistan minefields before they were cleared. With the benefit of hindsight we can all share a good laugh but it is worth learning a valuable lesson. It demonstrates that the level of comprehension of humanitarian demining issues requires widespread improvement. The fact that this discussion occurred amongst leading experts in the field demonstrates a serious lack of intellectual support.

There are many research groups focusing on the problem of mine detection. However, the number of research groups who focus on the broader aspects of humanitarian demining can be

counted on the fingers of one hand. There is no peer reviewed journal: the JMU Journal of Mine Action¹ is useful but most of the content appears to be anecdotal. More care with intellectual rigour will replace opinions with evidence, anecdotes with data, and arguments with analysis. This in turn will provide a reliable base on which decisions can be based and outcomes evaluated.

Technology Needs

We conducted a study of demining technology needs in several countries in 1999, and the full results have been published on our web site, available as a CD-ROM (Trevelyan, 2000).

The study was conducted by a systematic qualitative approach based on contemporary needs studies in the social sciences (see Appendix 1).

Aim of the Study

The study was commissioned by the US Army Night Vision and Electronic Sensors Directorate at Fort Belvoir, Virginia USA, to provide a data base of demining technology needs, prioritised where possible, and presented on a country-by-country basis.

The research guided us to define technology needs of deminers as

A technology needed by deminers is one which would measurably improve either safety, quality or cost-effectiveness without compromising the others if it were available in the form of equipment or other means. This includes technologies which are known, and possibly available for purchase now, and those which need further research and/or development.

Summary of Results

The most urgent technology needs expressed by the demining community are:

- **Mechanisation:** deminers need mine-resistant vegetation cutting machinery, and other multi-purpose machinery which can be adapted for demining and other construction tasks as required. They prefer versatile machines to special purpose machines. Much of this machinery is currently available from commercial suppliers, with some (mostly minor) modifications. Magnets can reduce later work by manual deminers by collecting surface metal fragmentation. Significant cost reductions and production rate improvements are achievable with more mechanisation.
- **Mine detection dog performance indicators:** deminers are concerned that dog performance cannot be relied on, and there is insufficient documented know-how and scientifically sound performance testing. A major international study has been commenced under the leadership of the Geneva International Centre for Humanitarian Demining (GICHD), but more resources are needed.

- Deminers often asked for detectors which can distinguish mines from metal fragments, either sensing explosive or other aspects of mines. The high false alarm rate from metal detectors and probing is a major cost factor.
- Quality control techniques: quality control is a major issue in many demining programs, perhaps causing more arguments than any other issue. The existing quality standard needs to be reviewed and replaced with more practical alternatives. More cost-effective quality control sensing technologies are also needed.
- Better protective equipment is needed. While there are good designs now available, comfortable protection from high velocity fragments is needed in some regions.
- There are many less obvious needs such as high quality drinking water, better uniform materials, better hand tools which are relatively easy to satisfy and could, when combined, lead to significant performance improvements.
- Information technology: deminers need better internet access, better mapping software, and better data collection and distribution between central databases and field offices. Aerial photography could help deminers in several countries, but its potential is only just beginning to be appreciated.
- Vegetation is a major problem in several countries. While machinery can help, in the longer term, the cost of having to clear vegetation with special vehicles before checking for mines is prohibitive. Methods of localising explosive contamination could greatly reduce environmental remediation costs in many countries, particularly the Balkans, Africa, Central and South America, South Asia, and South East Asia. Faster release of uncontaminated land can bring major economic benefits.
- Special operational needs: deminers expressed many special operational needs, such as clearing mine-contaminated rubble from buildings in Afghanistan, clearing mines washed into rivers in floods, deeply buried mines, and mines laid in mud flats or swamps where men and machines cannot get access.

Training Needs

Training needs in the mine action community have been well documented in recent UN reports. However, it is surprising that most of the emphasis in training should be directed at the small number of expatriate management staff. Training is required at all levels of demining organisations from deminers to directors. While there is support for training field deminers with "train the trainer" schemes, what is really needed is management training at middle levels of organisations for national staff. Between 25% and 40% of local staff, including deminers who are likely to be promoted to section leaders, require training in:

- Contract administration and management
- Quality management
- Accounting and finance
- Organisational behaviour
- Communications and interpersonal skills - written and spoken
- Language skills: regional languages and English
- Demining technologies
- Effective use of machinery and other capital equipment

Occupational health and safety
Socio-economic evaluation techniques
Geographic information systems
Management information systems

This investment in human resources does increase the mobility of local staff. For example a number of middle management and senior management staff from Afghan technical consultants, the largest demining organisation in Afghanistan, have been recruited by international demining agencies and are now working in other countries. While this increases the requirement for local training due to staff turnover it still represents an effective investment in the international demining effort. Furthermore, the skills which people learn to operate effective demining organisations represents an investment in the future of their country which is just as useful as clearing landmines.

Suggested Options for a Response

The needs identified by this study could be satisfied by a coordinated response from the donor community. Part of the reason why these needs have not been satisfied already is a lack of understanding of the real problems faced by deminers: aid donors, and in some instances demining program managers, are not fully aware of their needs.

Many of the technology needs can be satisfied with equipment which is available now, often at modest cost. Donor institutions could significantly increase the effectiveness of the resources they provide now by ensuring that these needs are satisfied. These needs include:

- **Mechanisation:** machines and appropriately equipped support organisations could significantly improve the cost effectiveness of several demining operations in a short time.
- **More mine detection dogs are needed:** properly used, dogs could improve the effectiveness of several mine clearance programs. Urgent research is needed to resolve apparent performance problems with mine detection dogs in several countries.
- **Better protective equipment is needed:** commercially available equipment could significantly reduce injuries to deminers.
- **High quality hand tools, high quality drinking water supplies, and more attention to details** such as uniform materials to improve deminer comfort could yield significant performance improvements at modest cost. Given that each deminer costs about US\$10,000 a year to support in the field (salary, equipment, supervision, training, logistics etc.) in the third world, and up to US\$50,000 or more in Europe, a 10% performance improvement could save about up to US\$5,000 annually for each deminer.
- **Information technology improvements** could also bring significant cost savings through better resource allocation.

Improving the Technology by Buying Equipment

Capital equipment for demining programs seems to be supplied on a very *ad hoc* basis. For example, the Afghanistan mine action program has requested donor support for more back hoe machines for several years. Recently a Japanese company persuaded the Japanese government to offer one of its specialised demining machines to the mine action program. This machine is new

level of ongoing support the offer was finally accepted. However, support for additional back hoes, which have a proven record of performance, is still not forthcoming.

Our survey of technology needs in demining programs showed that general-purpose and vegetation clearance machinery would provide short-term benefits in nearly every mine clearance program. There is an urgent need for donors to consider a coordinated program of investment in machinery. While this investment cannot be justified on the basis of individual projects, it can yield significant cost savings for all donors in the medium term.

By approaching such an investment program on an international basis it may be possible to reduce the influence of individual companies and place more emphasis on the operational needs of demining agencies.

Improving Technology by Research and Development

Other technology needs require further research and development. The US sponsored "2010 initiative" (Department of State, 1998) aims to mobilise about US\$1,000,000,000 yearly for landmine eradication. The research and development needed to satisfy most of the outstanding needs of deminers could be completed with approximately US\$30,000,000 yearly. However, most of the current research funding (perhaps US\$300,000,000 annually) is not being used in the most effective manner to solve demining problems.

The major part of the research effort is directed at high technology detectors, both vehicle mounted and man-portable. This research aims to satisfy the need for a detector which can distinguish mines from the metal fragments which confuse current metal detectors. However, this effort started in the early 1990's and has not yet yielded any useful improvements for deminers.

A relatively small research budget, better directed, could make much more impact if it pursues the following objectives:

- Find ways of measuring and predicting the performance of mine detection dogs.
- Develop effective quality measurement and assurance methods. (See Appendix 2)
- Find ways to survey and map mine and UXO contamination in large areas of terrain without the need for men or machines to enter the affected land. Promising methods include extending current air sampling methods where dogs sniff the samples, and the use of bacteria to indicate localised explosive traces in the environment. Aerial photography also shows some promise where vegetation is thin enough.
- Resolve special operational needs such as clearance measures for mud flats, rivers and sandy areas, residential areas in Afghanistan, deeply buried mines in marshes and salt lakes etc.
- Refocus research of detection technology at the problem of *reducing* the false alarm rate rather than *eliminating* false alarms.

If successful, these efforts would provide major improvements in cost-effectiveness in mine and UXO clearance, provided program managers can make effective use of them.

Allocating 15% of Funds For Process Improvement

Demining program managers find process improvement difficult because they have almost no resources to support it. Funding agencies will not provide additional funds for experimentation and development activities. Improving the process requires significant investment: donors need to provide for this if they are looking for cost-effectiveness improvements.

It is not uncommon for industries involved in significant technological improvement to spend 10 to 15 percent of their turnover on research and development activities and staff development. This level of support is essential if demining processes are to be significantly improved. One way to encourage this would be for donors to pre-allocate 15 percent of project funding specifically for overall process improvement and human resource development (training). It may not be possible to directly measure the degree of improvement achieved by such an initiative within the timescale of typical projects. However, this level of funding has to be committed as a forward investment for the longer term.

Process improvement activities require the following

- 1: Training programs to improve communication skills, technical competence, language skills, resource scheduling skills and the ability to operate in a large organisation.
- 2: Development of local operations research capabilities using national staff with sufficient funding to attract former nationals with research training to return to their homeland.
- 3: Technology research and development specifically directed at humanitarian demining issues and performed in collaboration with operational demining organisations. Funding for this activity could be pooled internationally and allocated on the advice of deminers and researchers together.

Supporting Research on Risk Management for Mine Contaminated Land

Several countries contained large areas of land with unknown or limited levels of mine contamination. For example in Croatia estimates range from 6000 sq km to 10,000 sq km of contaminated land, but the contamination density over most of that land is very low in terms of devices per sq m. In Bosnia-Herzegovina, we find a large proportion of civilian mine accidents occurring in areas where there are no known minefields. In Lebanon there are more civilian casualties than in Croatia or Bosnia Herzegovina and again there are large areas of land with unknown levels of contamination.

There is no foreseeable technology for economic clearance of these large areas of land. With present techniques there may never be sufficient resources to remove the contamination completely. Governments facing this problem need risk management tools in order to be able to use the land effectively if at all. There has been very little published work and only tentative research in this area.

A recent paper on risk management techniques in demining (Brown 1999) advocated the use of machinery as a risk reduction tool. While these suggestions are useful we can make little progress without extensive data and useful statistical models.

Researchers in Lebanon have conducted epidemiological studies of civilian populations affected by landmines and UXO contamination. They have collected data which links land use, activities,

need statistical methods to measure the extent of mine contamination in the areas where these people live. At the moment, no such data exists and there are no methods to collect this data other than the expensive alternative of complete clearance of the affected land. While complete clearance is obviously desirable, there is no prospect that sufficient resources for this will be available in the foreseeable future.

We need research on risk management, mine contamination measurement, and epidemiological studies of populations at risk.

While there has been little research on risk management there are well established technologies which could help people to live with mine contamination. Mine resistant vehicles have been in use in southern Africa since the 1950s. Recent research has established low-cost methods for manufacturing protective equipment for deminers which could be extended to provide some protection for people working in areas affected by landmines.

We have only just begun to accumulate tools and technologies for people to live with mine contamination. This is important because these techniques offer a way for people to make use of land resources which would otherwise be denied to them for decades if not centuries.

Support For Grant Application Process

Mine action program managers spend a significant proportion of their time seeking further funding for their programs. As the sources of funding become more diverse and the arrangements for funding become more complex this drain on management resources will worsen. The complex terms and conditions associated with project funding applications from donor governments require a high-level of expertise in writing applications. For example, applications to the Australian government have required detailed consideration of equity in gender participation in projects. In an environment such as Afghanistan a high standard of creative writing is required to address such issues. Therefore, it is only reasonable that donor governments provide some support for the grant application process.

Staff who are capable of writing effective grant applications are extremely costly to employ in mine affected regions (about US\$200,000 each year). Given that many grant applications are unsuccessful, it is not unreasonable to expect that 2 to 3% of the program cost will be involved in fundraising.

If donors need effective program management they must accept the need to provide separate resources for their grant application processes.

Researching the potential for Philanthropy and Micro Credit

As I indicated in the introduction the improvement in demining technology is only one of three aspects where improvement is possible. Another avenue for significant improvement is to open up alternative sources of finance.

The current sources of support for demining are:

- 1) international aid funds,
- 2) in kind support from international aid donors,

4) indirect host government funding, for example the use of military personnel in demining operations.

Most countries affected by landmines also have relatively weak political institutions and limited revenue from tax collections. They are often tightly constrained financially, and government employees are either poorly paid or not paid at all. Weakness at the political level often means that they major part of the economy operates outside institutional and government controls. This weakness significantly limits the ability of state institutions to participate in mine clearance activities. This also makes it difficult for international aid donors to contribute effectively. Donor states seeking "exit strategies" after a period of aid funding will be frustrated: state institutions will be unable to fill the gap. This does not mean that demining programs cannot be supported using local finance. It means that we have to look for alternative sources at the local level.

Broadly speaking there are two potential sources of funding. Even in the poorest regions it is possible to find extremely wealthy individuals and families. Many have had to resort to illegal quasi legal means to protect their wealth and the money is often placed with financial institutions outside the country. Some of these wealthy families are looking for ways of using their funds to benefit their communities however they need ways to contribute anonymously to avoid legal or political retribution. This may be due to political differences between these individuals and families and those in control of the central government.

The second source of funding comes from communities themselves. Micro credit schemes have operated successfully in several countries although they often require a high level of subsidy. Demining activities are relatively expensive compared to the economic return available from most of the land cleared and this makes it difficult to envisage a Micro credit scheme which does not require subsidy. However, existing demining operations are for the most part completely subsidised. It therefore follows that any contribution which can be raised through Micro credit or similar schemes represents an improvement on the existing situation because the total funding for demining is increased. Furthermore, the implementation of Micro credit schemes can significantly improve the level of financial skills in the communities affected and this represents an investment in the future of the communities.

It is time the international community addressed the resource input side of demining as a means of improving the process. We commenced this research about 12 months ago and our results can only be described as preliminary. However, we think there is as much potential in developing alternative funding sources and funding models as there is in technological improvement.

If this is to be realised, donor agencies and mine action agencies will need to work more closely with major non-government actors and communities, whose interests may differ markedly from government interests.

Conference Schedule

We could make much more effective use of our time with an agreed annual conference schedule. In the demining community it is almost possible to become a full-time conference attender given the number of conferences, committee meetings, working group meetings and workshops. Other international communities have evolved annual conference schedules to avoid this problem. Events such as workshops and committee meetings are planned to coincide with major international conferences. The conferences themselves consist of several sub-conferences so that specialist groups can meet at the same time rather than arranging separate meetings

Scholarships

A cooperative approach to training is needed. While the burden of demining rests on local communities, research is often conducted by those in developed states. In order to rectify this imbalance in technical know-how and empower those directly involved in demining to make technological improvements, technical and research training programs need to be established. A program of scholarships for appropriately qualified national staff to attend appropriate universities to acquire research skills and high level management skills would help to address the acute shortage of skills in several mine-affected countries. The scholarships would carry an obligation to return to the mine action program for a minimum period so that the benefits are retained in the affected country.

Avoiding Short Term Contracts

It is essential to avoid short-term contracts and staff appointments. I recently asked one major demining company whether they conducted long-term follow up on their clearance projects. "How can we do that if we are no longer in the country?" was the reply. "We only have a four-month contract". The appointment of technical advisers for a minimum period of 12 months, preferably 24 months, is also an issue with deminers. A deminer told us: "Some technical advisers with our program have been excellent. However, many technical advisers have come without any experience of demining and have only stayed long enough to find out that we know more than they do."

Given these opinions, we could argue that longer appointment periods will enable those unfamiliar with the situation to learn and then apply their knowledge and those already efficient in the techniques will be able to benefit the communities more, and the local deminers will be able to establish better working relationship with the 'experts'. Social interactions are also important. Conveying knowledge in the absence of social interaction may not always be effective: knowledge may be lost, misunderstood or cooperative learning may not take place.

Acknowledgements

The major part of the funding for this research came from the Night Vision and Electronic Sensors Directorate, US Army Fort Belvoir and private donations. The author acknowledges the contributions of many people to this work, particularly staff of the mine action centres for Afghanistan, Cambodia, Bosnia-Herzegovina and Croatia. Thanks are also due to his colleagues Dino Busuladzic, Saad Soliman, and Sabbia Tilli for support and field data, many people in the demining community for helpful suggestions and comments, and the director and the staff of the Hameed and Ali Research Centre for carrying out many field experiments to refine techniques described in this paper.

The author is also grateful for travel assistance from the French and the Australian Governments to attend the meeting to present this paper.

References

Aoun H. (1999) Personal communication. For more information refer to Landmines Resource Centre at the Institute of Health Sciences, Balamand University, Beirut.

Blaikie, N. (1993) Approaches to Social Enquiry. Polity Press, Cambridge, UK, 238 pp.

Brown, S. (1999). *Mine Action: the Management of Risk*. *Journal of Mine Action*, James Madison University, Vol 3, No. 1., <http://www.hdic.jmu.edu/>

Department of State (1998), *US Government, 2010 Initiative Announcements*. Available from <http://www.state.gov/>

GICHD (2000) Bryden, A. *Notes on 2nd meeting of users' focus group to discuss the review and revision of mine clearance standards*. Geneva International Centre for Humanitarian Demining, available at http://www.mineclearancestandards.org/minutes2_body.htm

Trevelyan, J. P. (1999) *An Alternative to the 99.6% Demining Quality Standard*. Technical Note, Department of Mechanical and Materials Engineering, The University of Western Australia, Nedlands 6907.

Trevelyan, J. P. (2000). *Demining Research at the University of Western Australia*. CD-ROM, Department of mechanical and Materials Engineering, The University of Western Australia, ISBN 1 74052 012 2.

Appendix 1: Obtaining the information on Technology Needs

The study was conducted by arranging country visits when possible by at least one team member. During each visit, team members discussed as many aspects of mine clearance as possible in the time available, and visited minefields, mined areas and other parts of the country. A detailed report on each country describes these activities and what was learned.

The research was based on a combination of qualitative and quantitative analysis methods. In order to collect information systematically, team members followed an interview guide which was designed as a 'survey instrument' using techniques currently used by social scientists. Since the aim of the study was to determine needs, many of which were not definable when the study started, the aim of the survey instrument was to allow interviewees to discuss the problems and challenges they encounter in demining with as little prompting as possible. The issues they raised were noted and explored further if necessary. Naturally, some issues required more specific, quantitative data to be completely understood. Once issues had been defined, it was usually easy to collect the data needed.

The success of this technique is amply demonstrated by several completely new concepts which arose from the study. These concepts were not part of the demining 'state of the art' when the study commenced.

Whenever it was feasible, the country reports were sent (in draft form) to relevant authorities to confirm their accuracy. Also, we had opportunities to discuss the draft report with several country representatives at a meeting of demining technology experts in Geneva in December. Several minor changes were made, and information on other countries (Chad and Nicaragua) was added.

In some instances, information was obtained from other experts who were familiar with countries we could not visit. These experts included:

Mr. Bill van Ree, Mine Action Consultant, former manager of Mine Action Program for Afghanistan, currently restructuring Cambodian Mine Action Centre.

Maj. Colin King, Mine and Explosive Ordnance Disposal expert and editor of Janes 'Mines and Mine Clearance'.

Mr. David Edwards, former Program Manager, UN Mine Action Program for Northern Iraq.

Each was interviewed using the survey instrument as a guide.

All the detailed information in the country reports will be added to the web site once the relevant country authorities have confirmed the validity of the information.

Appendix 2 Why is quality measurement important?

Measurement of quality performance lies at the heart of all quality management programs. Most texts on quality management assume the capability to measure quality. In typical industrial situations quality can be measured using standard instruments -- the process of obtaining measurements is usually taken for granted. In service industries quality is usually measured

through questionnaires or simple time measurements such as the time a customer waits to be serviced in a queue.

Quality improvement processes rely on measurement for evaluation. One cannot claim to have improved quality without being able to measure it with an accuracy considerably smaller than the degree of improvement.

Without quality measurement it is difficult to compare the quality level from different sources of supply. This lies at the heart of demining debates in several countries: are the commercial operators cutting corners by working too fast? Are the non-government organisations wasting donor funds by working too slowly and cautiously? How much does demining quality depend on the degree of supervision? What is the quality variation between different demining teams?

In most industries commercial competition has yielded significant price reductions and performance improvements. Yet commercial competition in demining is seen by many as a retrograde step: commercial competition and the profit motive are seen by these people as having no place in humanitarian demining. Their arguments have some validity while there is no effective means of monitoring quality. However, with an effective quality measurement system in place commercial competition is probably one of the best means of improving performance.

Deminers will make fewer mistakes if they receive immediate feedback. The quality measurement process introduced by Trevelyan (1999) provides an effective way of doing this. The more traditional approach which uses quality control inspections weeks or months after the original clearance operation is much less likely to be able to do this.

Appendix 3 Summary Table of Technology Needs by Country

(presented as a separate table)